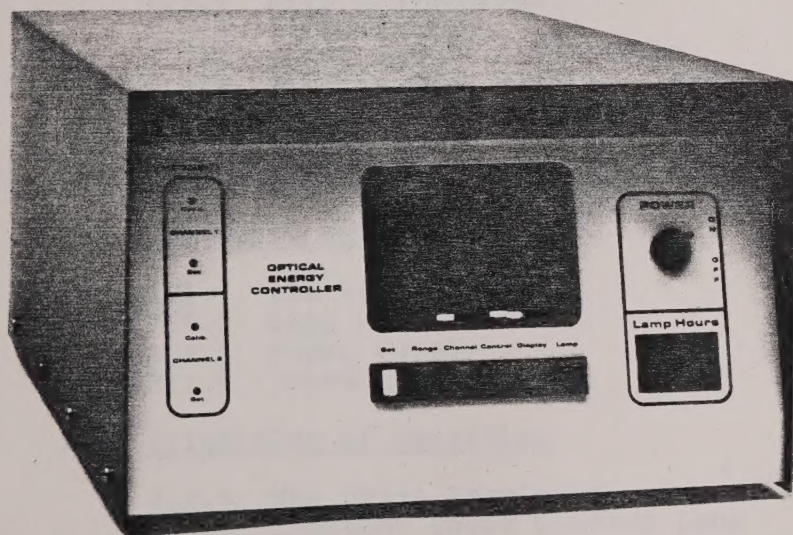


OPERATING & INSTRUCTION MANUAL
for

MIMIR OPTICAL ENERGY CONTROLLER

MODEL 505
SN 370039



Mimir

INSTRUMENTS Incorporated

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500 SERIES

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1. INSTALLATION AND ENVIRONMENTAL REQUIREMENTS

1.1 Unpacking

1.1.1 Inspection

After removing the foam pallet, check that you have the following items and that callouts on the packing invoice agree with the items within.

- 1) The Optical Energy Controller
- 2) Dual Optical Probe Assembly
- 3) Lamp cable and connector assembly
- 4) 500 Series Operations Manual

Verify from the labels on the rear of the Controller unit that it is set correctly for the type of lamp and its corresponding wattage. A label on the mounting plate of the Optical Probe details the optical wavelength for which the probe is set.

1.1.2 Instructions in Case of Damage

If there is any indication of abuse to the instrument due to shipping, notify the common carrier. All claims for damage must be filed against the carrier. See section 3 on Warranty.

1.2 Environmental Requirements

1.2.1 Utilities Required

The power requirements of voltage, line frequency and the maximum wattage drawn, are shown on a label on the rear of the instrument. Each instrument is capable of operating at main voltages from 100 VAC to 260 VAC and frequencies of 40 to 70 Hertz, however, a circuit breaker selection is required for

any set condition. Your unit will be wired internally for the power option specified on the purchase order.

1.2.2 Physical Environment

The Optical Energy Controller is designed to operate continuously at ambient temperatures of 4-30°C and to be stored or transported at temperatures up to 60°C.

The instrument will perform best and give the longest service if it is stored and operated in a clean, dry, non-corrosive atmosphere.

1.2.3 Exhaust Requirements

Internal cooling is via a ducted air design past the heatsink, powered by a small exhaust fan. Air is drawn in through slots in the chassis just behind the front panel and exited through the rear panel. The instrument will tolerate zero clearance along the top and sides, but the space set by the feet should not be restricted in any fashion. Additionally, a minimum clearance of 15cm between the rear panel and any obstructions should be maintained.

Although the exhaust of the Optical Energy Controller consists only of heated air, the lamp used with the controller may produce toxic emissions. See section 2.3.2 for details.

1.3 Coupling Procedures (Reference Illustration) No.1

1.3.1 Lamp Connections

A complete set of cables and mating connectors are supplied with each Controller. It is suggested that you replace the existing lamp housing cables with these for optimum performance. The cathode cable and connector are rated at 30KV, and the insulation of the cable meets MIL-W-16878 and UL 62 specifications. The white cable with large black connectors must go to the lamp cathode and the cable with the red connector must go to the lamp anode. The anode is at earth ground at the Controller.

Cathode-Rotate the connectors so that the guide tab aligns with mounting slot, then push so the two units mate. Engage the locking ring on its thread and while applying forward pressure rotate the ring until the units are fully mated and locked. This connector is an AMP type 853350-2.

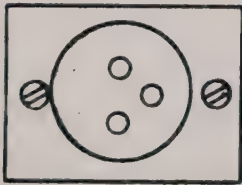
Anode - Align the mating slots of the two units and press forward until a "snap" is heard and the units are fully mated. This connector is an AMP type 53894-4.

For removal reverse the procedures above.

1.3.2 Optical Probe

The dual optical probe, with cable and connector, is supplied with each Controller. Align the connector

Optical Probe



Fan

120V 20W Max.

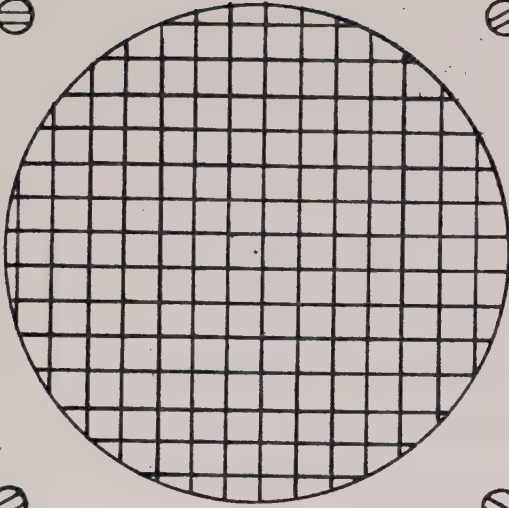
Interlock

LAMP



Anode +

Cathode -



OPTICAL ENERGY CONTROLLER	
LAMP POWER	MAINS
RATED _____ W	50 - 60 HZ
HIGH _____ W	_____ VOLTS
IDLE _____ W	_____ WATTS
LOW _____ W	



Mimir INSTRUMENTS INC. SANTA CLARA, CALIFORNIA U.S.A.	
OPTICAL ENERGY CONTROLLER	
MODEL:	_____
SERIAL No.:	_____
DATE MFG.:	_____

with its mating slot and push forward until the locking clip engages. To remove, press and hold the clip down while pulling firmly to the rear.

1.3.3 Start and Idle Interface

A provision for lamp start inhibit and for a remote Idle/Control signal is made via a 4-pin Jones type jack on the rear panel. The lamp start inhibit is utilized to prevent damage to connected equipment, by the high voltage RF pulse used in starting the lamp. The usual requirement is that the associated equipment be powered down during the starting sequence. This is easily accomplished by connecting Pin 2, through a suitable dropping resistor, to the positive rail of the power supply in the associated equipment and Pin 1 to ground rail; then whenever the supply is activated, the internal start circuitry of the Controller will be inhibited. Note that no other functions of the Controller are modified by this condition. The interface is via an optoisolator to prevent any ground loops. Electrical requirements are 20mA through, and a voltage drop of 1.6 Volts across the LED.

The remote Idle/Control interface is provided for the specific case where the associated light housing does not contain a shutter, or where the optical sensor probe is used to view the light prior to the

shutter. Use of this input will then preserve the useful function of having the lamp run at an optimum level (Idle) between exposures. An optoisolator, as before, is used as the interface with connections of positive current to Pin 4 and ground to Pin 3. The front panel Control switch must be pushed to the In position for the Controller to activate the optical loop. This interface will then disable the optical loop whenever current is provided to the LED and the lamp will return to its Idle wattage.

The mating plug is a Jones or equivalent type P-304-CCT.

1.3.4 Fan for Lamp Housing

A provision for supplying 120 VAC power to the cooling fan in the associated light housing is provided by this jack. Note the voltage will be $120 \pm 10\%$ regardless of the actual input mains value, but the frequency will be that of the mains. This output is useful in that a universal fan can be utilized for the light housing. Use a Jones or equivalent 3-pin plug type P-303-CCT connected in the following manner: Black wire to Pin 3, white wire to Pin 2 and green (ground) wire to Pin 1.

1.3.5 Isolating Difficulties

When first installing an Optical Energy Controller it is suggested that you also start with a new short

arc lamp. Check and clean all electrical contacts within the lamp housing. Be especially critical of any crimp type contacts and, if there is evidence of corrosion or oxidation, replace them. The majority of apparent Controller malfunctions can be traced to faulty or incorrect electrical connections within the lamp housing, so a few minutes spent in scrutiny can prevent several hours of frustration, especially in tracing false symptoms due to intermittency. Improper mating of the Cathode HV connector will also prevent the lamp from starting. Review section 1.3.1 and ensure that the connector shaft is fully inserted and the locking ring engaged.

2. OPERATING AND MAINTENANCE MANUAL

2.1 The Short Arc Lamp System

2.1.1 Arc Lamps

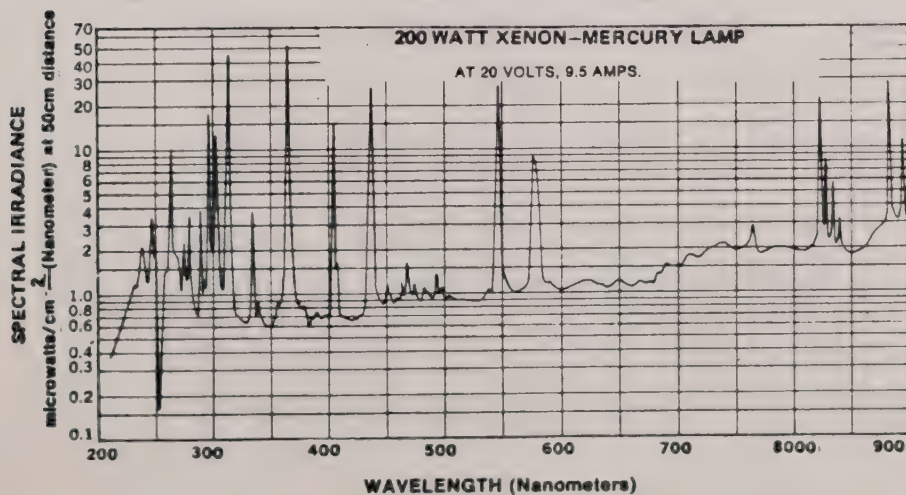
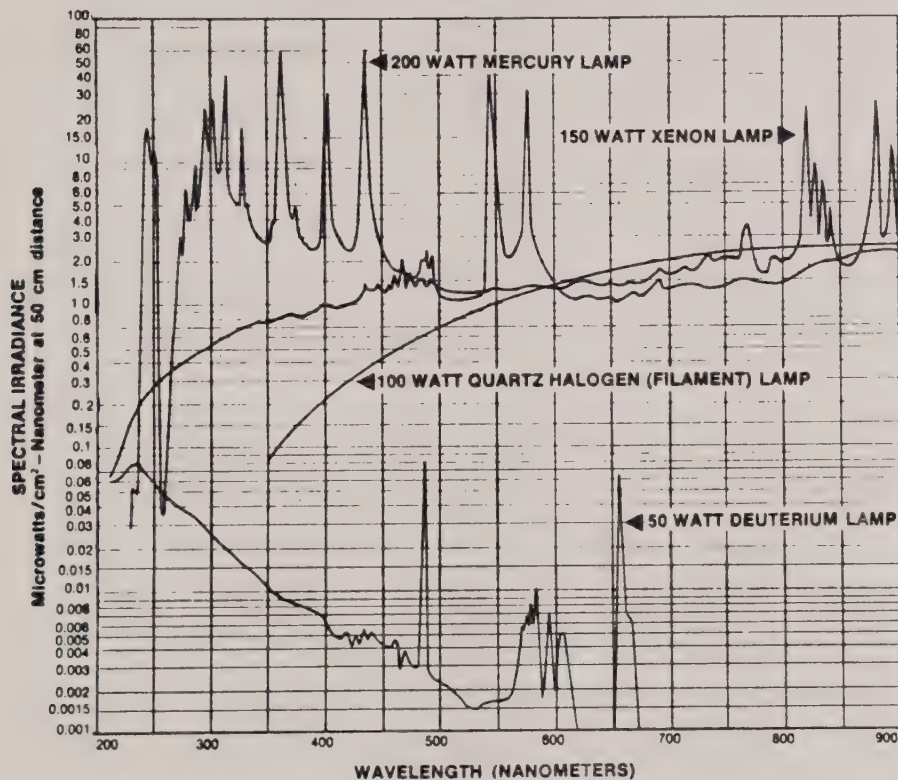
Mercury, mercury-xenon and xenon arc lamps operate at very high pressure producing extremely bright concentrated sources of light. The spectral distribution consists of resonant lines superimposed on a thermal radiation continuum from the heated incandescent plasma. A typical xenon lamp operates at 6000° Kelvin color temperature, approximately that of the sun. Salient characteristics common to most of these lamps are:

- 1) A clear quartz bulb, either spherical or elliptical in shape, with extensions at opposite ends constituting the electrode terminals.
- 2) A pair of electrodes with relatively close spacing, approximately 1mm to 1cm depending upon the wattage rating (hence the term "short arc lamp").
- 3) A filling of gas or vapor through which the arc discharge takes place.
- 4) Extreme electrical loading of the arc gap, which results in a very high luminance.

This results in internal pressure of several atmospheres and bulb temperatures as high as 900°C. These factors alone should indicate that precautions are necessary to protect people and adjacent equipment should the lamp fail violently.

- 5) The requirement for a momentary high-voltage ignition pulse and a ballast or active circuit to limit current during operation. Short arc lamps are efficient ultraviolet producers. Mercury produces an intense line spectrum from 230 to 400nm. Xenon produces an intense line spectrum from 230 to 400nm. Xenon produces a UV continuum from 190 to 400nm.

TYPICAL OUTPUT SPECTRA



A mercury or mercury-xenon arc lamp will have a small pool of liquid mercury, when cold, in a bulb filled with a rare gas (argon or krypton). The gas is necessary to start the lamp and establish the arc. The heat generated will then vaporize the mercury until, at operating temperature, all of the mercury is vaporized. Starting from near atmospheric pressure at room temperature, these lamps will operate at 50-70 atmospheres when operating. Typically, five to fifteen minutes are required for them to warm up and reach their operating pressure.

The mercury-xenon lamps have xenon as the starting gas. The xenon speeds warm up, increases stability and lengthens the life of the lamp.

Xenon arc lamps are filled with a few atmospheres pressure at room temperature and rise to 50-70 atmospheres at running temperature. The output spectrum combines thermal radiation from the plasma with the xenon line spectrum superimposed. Warm up occurs in less than five minutes.

Average life of a Hg lamp is about 400 hours when operated at rated wattage, while that of a Xe or Hg-Xe is about 1000 hours. Average life is based on deriving a useful radiant output from the lamp.

During operation atoms of tungsten are boiled off the electrodes due to the electron bombardment and are deposited on the inside walls of the quartz envelope, thereby reducing the radiant output and increasing the effective arc gap. The lamp, therefore, requires a greater voltage between the electrodes to maintain the required electrical field. See section 2.2.2 and 2.4.3.

2.1.2 Lamp Housing

The housing system should provide all of the electrical and mechanical requirements for the operation of high pressure arc lamps. These include mounting of the lamp for stress free expansion, explosion protection, high voltage electrical inputs and provisions for external adjustments of the lamp position and/or lens and mirrors. The housing should also include some means of cooling which will maintain the lamp at its optimum operating temperature, neither over or under cooled.

For the purpose of usefulness in photolithography the housing should contain some means of collecting and projecting forward the desired spectral radiation from the lamp.

2.1.3 Power Supply

The power supply for an arc lamp must take into consideration the lamp's operating characteristics,

for although the supply can drive the lamp over a large latitude of electrical input powers, it is the lamp characteristics alone which will dictate the actual value of voltage and current. A basic supply should have the following specifications:

- 1) A low ripple regulated DC output.
- 2) A high voltage starting circuit (15KV or higher).
- 3) A ballast or active circuit to limit current to the lamp during the warmup period.
- 4) A means to adjust the lamp power output.
- 5) A line isolation transformer for safety.

2.1.4 Constant Intensity

In the preceeding section on the short arc lamp system, the discussion has dwelt on operation of the lamp in the most practical sense, that of constant power. However, even if conditions are optimized for the three factors of lamp, housing and supply, the end results would not satisfy the requirements dictated by most microphotolithography systems.

The chemistry of a photoresist requires that a given amount of energy (Joules/cm^2) be absorbed by the molecular structure over a finite period of time (window of the process) for a successful print. It is also desirable that the process be repeatable, wafer to wafer, and aligner station to aligner station. Since the radiant output of a short arc lamp begins to deteriorate from the moment it is started, and the decline is accelerated as the lamp ages, one is faced with wildly varying illuminating conditions at the plane of interest. An analogy of this problem

would be that of a photographer who was charged with the responsibility of obtaining repeatable high resolution prints, using a camera with fixed shutter speed and "f" stop, out-of-doors from high noon until sundown. This, obviously, would result in prints ranging from overexposed, to acceptable, to underexposed. The only hope of success would be to move indoors where a source of light could be adjusted prior to each exposure to produce a constant illumination of the object. In a similar manner, the optical control loop of the Optical Energy Controller achieves the same result. As the shutter opens and light is detected in the forward path, the Controller will electrically drive the lamp to a power which will produce a preset level of intensity (mW/cm^2) at the wafer plane. During the interval that the shutter is closed, the lamp power will be returned to a value at or near its rating (Idle) for optimum life. It should be noted that lamp power in the Control mode may be dependent on the selected Set value of intensity, the efficiency of the lamp and associated optical systems, and the age of the lamp. There are limitations, however, as to the range that a lamp can be driven: too low a value and the arc will extinguish, while too high a value will result in an explosion of the bulb. These extremes are avoided by circuitry within the Controller which set upper and lower values of

power that the unit will deliver. A rating label on the rear panel contains the exact value for which your unit is set.

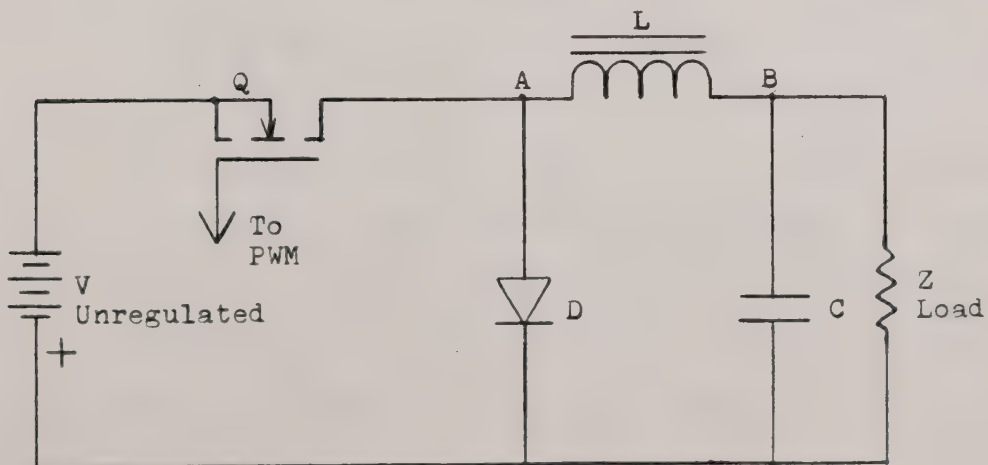
By running your process with a system which maintains constant intensity, the variances due to lamp emissions and aging disappear, and it becomes quite easy to characterize and optimize a process for any set of conditions. Additionally, most find that their yields increase significantly (some as much as 50%) and that useful lamp life is extended.

2.2 Principles of Operation

The basic circuit of the Optical Energy Controller is a stepdown switching power regulator which is controlled by a lamp, voltage-ampere servo loop. The reference for this loop may either be a fixed value (idle or constant power) or a value derived from the optical control loop (constant intensity). Switching semiconductors are DMOS transistors which are operated at a rate of 50 KHz. Isolation from the line voltage and adjacent circuitry is achieved by a specially wound transformer, which also results in eliminating the EMI from the switcher being transferred by to the mains. Additionally, the output transistors are isolated, by means of a high speed optoisolator chip, from the low signal level drive and control circuitry.

2.2.1 The Basic Regulator

For those who are unfamiliar with the actions of a stepdown switch, a brief review is in order. Referring to the following diagram, let us trace the action of the various parts.



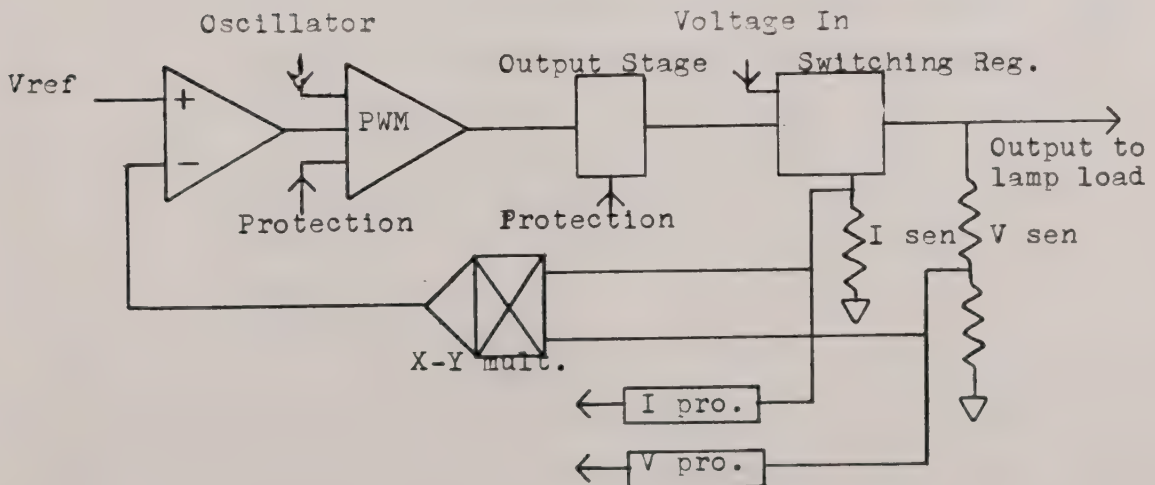
Q is the DMOS transistor whose sole function is that of a switch; the device is either shorted and the voltage from the unregulated supply is applied through the inductor L to the load, or the device is off, and Q is effectively removed from the circuit. The inductor L serves as an energy storage reservoir, storing energy when Q is on and releasing energy to the load when Q is off. The diode D provides a current path for L in the discharge mode. Capacitor C in conjunction with inductor L, forms a low pass filter to smooth the output voltage. If the voltage at point B is monitored and used to control the output pulse width of the pulse modulator circuit, the following operation of state prevails.

$V_{out} = \frac{V_{in} (T_{on})}{T}$ where: V_{out} is the voltage applied to load. V_{in} is that supplied from the unregulated supply. T_{on} is the width, in seconds, of the switched voltage (Q is saturated). T is the total period, in seconds, of the reference clock; in our case $T = \frac{1}{50 \text{ KHz}} = 20\mu\text{S}$. As an example: if the voltage of the supply was 100V and the desired output is 50V, the PWM would need to supply an "on" period of $10\mu\text{S}$ or 50% duty cycle. By the same principle, an increase in the "on" time to $15\mu\text{S}$ would give an output voltage of 75V, and a decrease to $5\mu\text{S}$ would result in 25V being delivered to the load. Note also that

if point B was compared to an accurate internal reference voltage, that the value of the unregulated supply could also vary and the output voltage would remain fixed due to the compensating action of the PWM circuit.

2.2.2 Constant Power Control Loop

In addition to providing adequate output voltage stabilization against line voltage and load changes, the control module must give fast protection against overloads, equipment malfunction and the effects of device switch on. In addition, a soft start is incorporated to prevent excessive inrush currents due to the initial capacitor load. The following diagram illustrated the principal control loop of the Optical Energy Controller.



Since we are interested in constant power, both the output voltage and current into the lamp load are sensed. These signals are combined via a 4-quadrant x-y multiplier to produce the product of the function (Watts) and fed to the input of an error amplifier, where it is compared with a reference voltage, the desired "Idle" power setting.

The output of this amplifier is connected to an input of the pulse-width modulator (PWM). Another input of this modulator is used for a sawtooth oscillator signal. As a result of these two inputs, a rectangular waveform with the frequency of the oscillator emerges at the output of the PWM. The pulse-width of this waveform is determined by the output voltage of the error amplifier, therefore as the width of the pulse is varied, the "on" time of the FET in the switching regulator will also vary and consequently the amount of energy taken from the input voltage. Over-voltage and overcurrent protection is realized by circuit blocks which monitor these functions and activate appropriate inputs of the PWM and its associated output stage.

2.2.3 Optical Control Loop

Incident light energy is converted into a proportional electrical current by means of a silicon photodetector. This current in turn is converted into a more useable voltage function by a logarithmic amplifier, current

to voltage circuit. Decade and calibration gain is performed by a matching antilogarithmic circuit so that the resulting voltage output is proportional to input current and modified only by the loop gain required to bring the circuit into calibration. A reference voltage, the desired intensity set, is supplied to the noninverting input of an operational error amplifier. The intensity voltage from the current to voltage converter is supplied to the inverting input. The output of this error amplifier is fed to the control loop (Section 2.2.2) where it replaces the reference, "Idle", voltage. When so connected the action of the overall system servo loop causes the lamp to be driven to a level, which will provide an intensity equal to the value set by the reference voltage.

Another amplifier acts as a buffer to drive the minimum intensity trip circuit in the control loop. A variable window detector locked to the set reference voltage provides a visual indication, via a front panel LED whenever the input intensity is within $\pm 1\%$ of the set value.

A full description of each of the functions is contained in Section 2.4.1 Control Panel of this manual.

2.2.4 Optical Sensor

The photosensors used in the dual probe assemblies are selected silicon photocells with enhanced efficiencies in the UV spectrum. Bandpass glass absorption filters or thin film dielectric filters are used depending on the particular wavelengths of interest. Unless otherwise specified the filter assembly is designed to operate in an intensity field which is 1 to 10 percent of that which is incident upon the plane of interest. The following graphs of response illustrate Mimir's standard line of available probes. For convenience these graphs are normalized to 100% and incorporate both the composite transmission of the filter used and the quantum efficiency of the individual detectors. Other or custom bandpass responses are available on special order.

Graphs of standard UV, Visiable probe responses

Graphs of standard DEEP UV probe responses

2.3 Hazards

2.3.1 Electrical

The electrical requirements of voltage and current required to run a short arc lamp constitutes a lethal combination. Starting ignition voltages are 30KV and open circuit potentials range up to 180 VDC at currents between 8 and 50 amps. When performing any maintenance to the Optical Energy Controller, lamp housing or lamps, where any chance of contact exists, insure that the power switch is in the "off" position.

2.3.2 Exhaust Requirements

All short arc lamps produce toxic ozone due to the radiation emitted below 200nm. Ozone attacks the mucous membranes of the respiratory system, producing symptoms similar to pneumonia. The effects are accumulative. The smaller wattage lamps, xenon to 200 watts and mercury to 500 watts, should only be operated in a well ventilated area. Larger wattage lamps should be vented out of the room.

2.3.3 Lamp Explosion

These lamps operate at extremely high pressure (50-70 atm) and are therefore subject to explosion. They must be operated within a protective housing. Additionally, xenon and mercury-xenon lamps, even when cold, are still above atmospheric pressure and should be handled with protective face shields and gloves.

2.3.4 Eye and Skin Safety

The shortwave ultraviolet light produced by these lamps can cause erythema of the skin (similar to sunburn) and conjunctivitis. In addition the large infrared output can cause retinal burns resulting in blindness. Wear UV and IR absorbing goggles and protective clothing when working in the vicinity of these emissions.

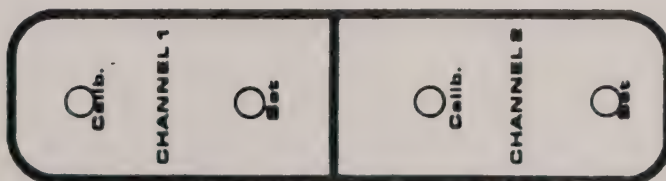
2.4 Operating Instructions

2.4.1 Control Panel

The Mimir Optical Energy Controller is designed for ease of operation and provides for status display of the exact mode and condition of operation by means of a series of visual and audible enunciators. Refer to illustration No. 2 or to the front panel of the actual instrument, as each control or indicator is defined by the following descriptions:

Right Side of Instrument

Power Switch: Activates a dual magnetic circuit breaker which supplies main power to the instrument. The rating of these breakers is dependent upon the lamp output power to which the instrument is set, and to the AC power option selected. Should an overload or malfunction occur, the switch will automatically trip to the "Off" position. There are no difficult fuse posts to reach or fuses to replace.



**OPTICAL
ENERGY
CONTROLLER**

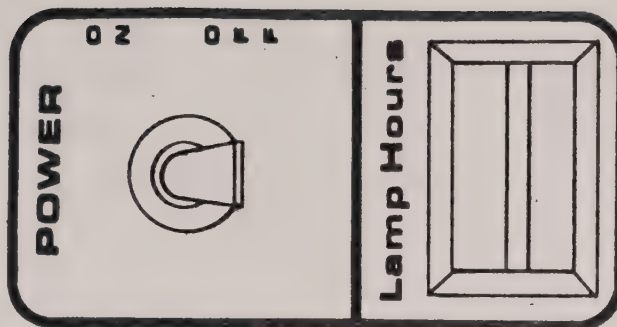
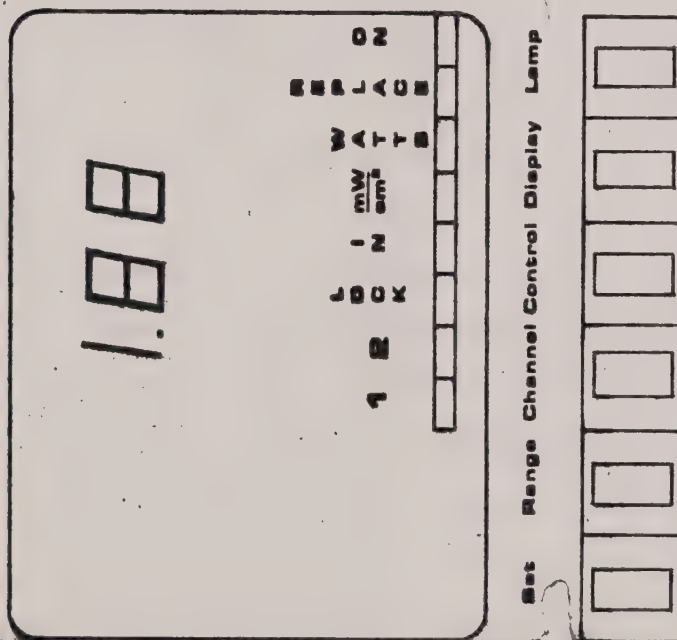


Illustration No. 2

Lamp Hours: This is a true lamp hour meter recording the passage of time only when the connected lamp is actually in operation. The unit has five digits, records to the nearest 1/10 of an hour, is nonresettable and unaffected by the frequency or wattage of the mains supply.

Center of Instrument

Display Panel: Contains a 0.5 inch high $3\frac{1}{2}$ digit LED display which will provide a readout of electrical power delivered to the lamp (watts), or radiant power (mW/cm^2) delivered to the plane of interest, as selected by the Display mode switch described below. In addition, the panel contains eight LED's which indicate the status of the instrument. Reading from left to right they are as follows:

Channel 1: The optical control loop is operating from the lowest wavelength sensor and the front panel potentiometer in the Intensity Channel 1 block will effect the intensity settings of the lamp in operation.

Channel 2: The optical control loop is operating from the highest wavelength sensor and the front panel potentiometers in the Intensity Channel 2 block will effect the intensity settings of the lamp in operation.

Control Lock: When lit, the optical control loop has closed and the intensity of light striking the sensor probe is within 2% of the value set by the Intensity Set potentiometer of either Channel 1 or Channel 2 as selected. When the instrument is calibrated and the Control In mode selected this LED should be lit.

Control In: Will light when the control mode has been selected. The optical control loop will then activate whenever light is incident upon the optical sensor and the remote Idle/Control interface is not activated.

mW/cm²: The digital display readout is that of radiant energy delivered to the plane of interest.

Watts: The digital display readout is that of electrical power delivered to the operating lamp.

Lamp Replace: The electrodes of the lamp have eroded past the point that the maximum voltage for that wattage, as internally set, will sustain an electrical discharge, and the internal safety system has shut the lamp off. The defective lamp must be replaced or ohmic contacts, if they exist, must be removed before the instrument will operate.

Lamp On: The connected lamp has been ignited and is operating.

Mode Switches: Six color coded push button switches enable the operator to select the desired mode of operation. From right to left they are as follows:

- 1) Lamp: Green-momentary. Press and hold until Lamp On indicator lights, to start lamp. Press and release to turn lamp off. Ignition is automatic and will shut down following start.
- 2) Display: Blue-latching. In the "In" position, the display readout will be in watts and the "Out" position will display mW/cm^2 . Appropriate indicator LED's will light as illustrated above.
- 3) Control: Red-latching. In the "Out" position, the Controller operates in the Idle or constant power control loop. In the "In" position, the Controller operates in the control or optical control loop.
- 4) Channel: Blue-latching. Selects whether Channel 1 or Channel 2 sensor is controlling the optical loop, and which block of control potentiometers are activated. Indication is by appropriate status LED as explained above.
- 5) Range: Blue-latching. Provides a decade gain change to the optical amplifiers and the corresponding reference voltage to the intensity set potentiometers. The "Out" position provides for intensities of 0 to 100.0 mW/cm^2 , while the "In" position is for intensities of 10.00 mW/cm^2 or lower. Indication is by decimal point location in the display when set to display radiant intensity.

MARC

6) Set: White-momentary. When pressed, and the display is set to radiant energy, will display the value of intensity to which the lamp is to be controlled.

Left Side on Instrument

Channel 1 Calibrate: Potentiometer for adjusting the gain of the optical control loop.

Channel 1 Set: Potentiometer for adjusting the value to which the lamp output is driven.

Channel 2 Calibrate: Potentiometer for adjusting the gain of the optical control loop.

Channel 2 Set: Potentiometer for adjusting the value of intensity to which to lamp output is driven.

2.4.2 Starting the Lamp

Insure that the proper cables are mated to the rear panel of the Controller as defined in section 1.3 and that the power cord receptical is connected to the proper mains voltage as shown on the back label. Flip the green toggle of the Power Switch to the "On" up position. The display should light along with several of the status LED's. Place the Display Mode Switch to the Watts (in) position. Place the Control Mode Switch to the Idle (out) position. Press the green lamp switch in and hold until the Lamp On status LED is lit, then release the button. Ignition is automatic and the high voltage start circuit will shut down upon commencement of current flow through the lamp. Following ignition, the display will show some value of watts that is below the normal Idle set. This will slowly increase as the lamp reaches its normal operating conditions of temperature and pressure. After a few minutes of operation, the display will read the correct Idle Set level; however, the radiant output will continue to climb. This is quite normal, due to the functional characteristics of the lamp (see section 2.1.1). The lamp can be extinguished by pressing and releasing the Lamp Switch. Note that this switch is the primary lamp start/stop function of the Controller and there is no need to kill the power via the main power switch

under normal usage. During the Lamp Off quiescent mode, the only power drawn from the mains is used to run the fan and the display LED's. The Models 505 and 507 require only 17 watts and the Model 515 requires 34 watts.

Should the lamp fail to ignite or to extinguish following a few minutes run, proceed to Section 2.7 to isolate and correct the malfunction. Note that a pulsing audible alarm will sound to indicate a "Lamp Out" condition only if a successful lamp start has been accomplished.

2.4.3 Operational Checkout

Assuming you have achieved a successful lamp start and warm up from the procedure above, we shall proceed. Check that the wattage as displayed agrees with that listed on the rear label for the idle level within ± 2 watts. Leave the control in the Idle Mode and cause the Display to read mW/cm^2 by pressing the Display Switch to the Out position. Open the shutter so that light now strikes the optical sensors in the probe. While in Channel 1 adjust the Intensity Calib. potentiometer so that a reading, less than 10 (between 3 and 8 mW/cm^2 preferred) is obtained on the display. Switch the Range and verify that there is a scale shift (of approximately a decade) on the Display, i.e., 3.00 to 03.0. Switch to Channel 2 and repeat.

While in Channel 2, press the Set Switch "In"; the Display will give the Intensity Set value as determined by the Intensity Channel 2 Set potentiometer. Verify this operation by adjusting this potentiometer so that the reading corresponds to the intensity level seen by the optical sensor. The Control Lock LED should light. Repeat for Channel 1. This concludes the basic checkout.. You have verified the correct operation of the Set, Range, Display and Idle functions of the Controller and are ready to proceed to the section on Optical Calibration. If any difficulties were encountered, proceed to Section 2.7 to isolate and correct any malfunctions.

2.4.4 Optical Calibration

For the purpose of this section of explanations, it will be assumed that the lamp has started and has warmed to its Idle running temperature per instructions in sections 2.4.2 and 2.4.3 above.

In order for the ensuing operation to have a valid and repeatable result, it is necessary to use a calibrated UV Powermeter whose optical bandpass filters are identical to those of the optical probe used in conjunction with your 500 Series Controller. We recommend using a Mimir Model 100 or Model 150.

Set the Control switch to its "Out" (Idle) position and the Display switch "Out" to read mW/cm^2 . Set

the Channel to 1 (in the standard probe this corresponds to 365nm) and place the probe of the UV Powermeter on the plane of interest at a fixed point. Open the light housing shutter so that light is incident upon the probe. Note the value indicated on the Powermeter and set the Range on the Controller to correspond. If this is greater than 7.5 mW/cm^2 you must use the 0-100 mW/cm^2 range. Turn the Channel 1 Calib. potentiometer counterclockwise five revolutions to its midscale location. Check the Controller Intensity display against that of the external Powermeter. If it falls within the range of +50% to -30%, the energy level on the optical probe is correct and you may proceed with the optical calibration procedures. Should this reading fall outside the quoted deviation go to Section 2.5.1 and perform the adjustments as required to bring your system into the linear operating region.

Adjust the Intensity Calib. potentiometer on Channel 1 so that the two values (Powermeter and Controller) agree. Hold the Set switch "In" and adjust the Intensity Set potentiometer on Channel 1 until the set value agrees with that of the Powermeter and Controller. Note that the Control Lock LED will light at this time indicating conjunction. Press

the Control switch "In" to its ON position which will activate the optical control loop. Check that the Intensity setting of the Powermeter has not changed. If a change has occurred carefully readjust the Intensity Calib. potentiometer until the original value is obtained. Channel 1 is now optically calibrated. Adjust the Set potentiometer to achieve the desired intensity settings.

Now proceed in a similar manner for Channel 2.

2.4.5 System Checkout

Following optical calibration, you may desire a verification and demonstration of the upper and lower power limits to which a lamp can be driven. If the Controller is still set in Channel 2 use the appropriate Intensity Set potentiometer to reduce the value of the Set Intensity (counterclockwise rotation). The Powermeter and Controller reading should track. Continue rotation until the Control Lock LED goes out. This is the lowest electrical power to which the lamp can be driven. By switching the Display to read Watts, this value can be compared against the reading given on the rear label. Return the Display to mW/cm^2 and advance the Set potentiometer clockwise. The Control Lock LED will light and the value of intensity will begin to increase. Continued advancement will result in an audible alarm sounding and the Control Lock LED will go out. This is the

maximum power that can be delivered and can be verified as before. Set the Control switch to its "Out" (Idle) position. The lamp power will be reduced to that read in Section 2.4.2 and the alarm will cease. Reduce the Intensity Set below this value and press the Control switch to its "In" (control) position. The intensity should increase to the value set and the Control Lock LED light. Close the shutter on the light housing and the intensity should drop to zero and the lamp power return to its Idle Set value.

2.5 Physical Calibration

There are obvious limitations in what can be provided in terms of loop gain within the optical amplifier chain of the Controller. Additionally, short-arc lamps can only be operated safely over a limited range of input power levels. Thus in this section we will deal with the physical calibration of the system as a whole, which will include the Controller, the associated short arc lamp and the light housing.

2.5.1 Optical Gain

As you recall from Section 2.4.1 the Controller is designed to operate in one of two ranges; $0-10\text{mW/cm}^2$ or $0-100\text{mW/cm}^2$. Optical loop gain is switched by a factor of one decade when the ranges are changed. For each range the action of the Calib. potentiometer allows adjustment over another decade. These gain functions are programmed to operate correctly whenever the probe is exposed at an energy level which is between 2 to 10% of that, in the main beam. On most

systems the probe is placed somewhere off axis within the optical path; i.e., behind a cold mirror or using the reflection off a parallel plate beam-splitter. If the energy level within your system falls outside the 2 to 10% range, because of location or the physical properties of the optical elements utilized, some modification of the probe aperture, the probe location, or in extreme cases, the electric gain of the Controller will be required.

When the energy is too high, adding a single optical stop or an additional diffuser to the probe aperture will usually solve the problem. For a stop, the level will drop in direct proportion to the area. A standard probe has an aperture diameter of 0.290 inches and an area of 0.066 inches. Any opaque material will suffice. A piece of .003 inch thick frosted mylar over the aperture will drop the intensity reading about 30-70 %.

If the probe is behind a cold mirror, which is only partially coated, changing to one having a higher reflectivity will also accomplish the desired effect.

The decision as to which methods to use must be based on the individual system and on the constraint of time expenditures to achieve the end goal.

When the energy is too low try relocating the probe

to a different location in the optical path where a higher energy density can be obtained. If behind a cold mirror it should be changed to one having a lower reflection and hence a higher reflection.

In cases where mechanical corrections cannot bring the system into the desired calibration range, Mimir can supply a custom Optical Control Board assembly to incorporate the required gain.

2.5.2 Lamp Intensity

Output intensity from a short arc lamp will vary in direct proportion to the lamp input power. This input power, however, is limited by the physical characteristics of the lamp in operation. The efficiency of the lamp housing will also contribute to the actual amount of energy density which will be available. Considering all these factors, it is apparent that both a maximum and minimum of light intensity will exist for any set of conditions; lamp size, lamp housing and required lamp safety limits.

In order to calculate these points we need only consult the power limits listed on the rear label of the Controller and measure the intensity level at "Idle" with a new lamp.

For the sake of an example let us assume we are dealing with a Model 505 which is set to power a 200 Watt

Hg lamp. The label would list the lamp power levels thusly:

LAMP POWER	
RATED	200 W
HIGH	260 W
IDLE	195 W
LOW	135 W

Let us further assume that we measure 6mW/cm^2 at 365nm on our plane of interest, using an external Powermeter, with a new lamp installed and the Controller's Control switch set to the out position. For the High limit:

$$\frac{\text{Lamp power High}}{\text{Lamp power Idle}} \times \text{Intensity at lamp power Idle}$$

$$\frac{260}{195} \times 6 = 8\text{mW/cm}^2$$

For the Low limit:

$$\frac{\text{Lamp power Low}}{\text{Lamp power Idle}} \times \text{Intensity at lamp power Idle}$$

$$\frac{135}{195} \times 6 = 4.15\text{mW/cm}^2$$

It follows from the example that the intensity limits to which the lamp and system can be driven are from 4.15 to 8mW/cm^2 or approximately plus or minus 30% of the nominal value obtained at Idle. This relationship will be command to most setups and in fact the values given in the example are typical for a 200W wafer exposure system.

These values of intensity, however, do not determine the practical limits at which a system should be

operated. The major trade off will be lamp life versus lamp intensity out.

Life of a short arc lamp approximately varies inversely to the 12th power of input power. Stated in equation form this becomes:

$$\left(\frac{P_{\text{rated}}}{P_{\text{applied}}} \right)^{12} = K \text{ (Lamp life at rated power)}$$

If you recall from Section 2.1.1 that the average life of a Hg lamp is about 400 hours and apply the number to the quotation above, the useful life of a 200W lamp will be extended by a factor of 1.355 by powering at a reduced input of 195 Watts.

$$\left(\frac{200}{195} \right)^{12} = 1.355 (400) = 542 \text{ hours}$$

Should the lamp be required to deliver an intensity level which necessitates going to 260 Watts, it can be readily shown that its useful life will be reduced by a factor of .0429.

$$\left(\frac{200}{260} \right)^{12} = .0429 (400) = 17.17 \text{ hours}$$

This factor will be modified by the action of the duty cycle requirement of the actual time spent at 260 Watts versus that spent at 195 Watts. Keep in mind that the useful life values usually mean the time required for the initial intensity value to decay to 50%.

Summarizing the concept; the higher in power the

the lamp is driven the shorter its useful life. Ideally for optimum performance one should set the exposure intensity at or below the value measured at the Idle power level. Should your requirements dictate otherwise, be aware of the tradeoffs involved.

If a higher intensity is required consider optimizing the optical elements within the lamp housing. There are large variances in the reflectivity of mirror surfaces and in many cases exchanging a partial Al mirror for a full dielectric surface will give you a 15% increase. If no further improvements in the optical system can be obtained the only alternative would be going to the next higher wattage lamp, i.e., 350 W Hg rather than a 200 Watt.

For those whose process require an intensity which is below the value at the low set point changing the mirror in reverse may prove useful. For an extreme case consider using a neutral density filter in the light beam. Rather than the typical gelatin filters, a fine metal mesh screen or etched metal filter will give superior performance especially in the UV regions.

2.6 Instrument Performance Specifications

2.6.1 Technical Specifications

Model 505 Optical Energy Controller

<u>Output:</u>	500 watts maximum continuous. 130 Volts DC open circuit. 8 amperes active current limit.
<u>Efficiency:</u>	greater than 90% power in to lamp, power out +17 Watts.
<u>Regulation:</u>	±.5% over selected mains input range.
<u>Ripple & Noise:</u>	less than 50 mVpp - mains fundamental and harmonic, 50 KHz.
<u>Response Time:</u>	less than 1ms electrical (actual system dependent on lamp thermal response).
<u>Lamp Ignition:</u>	30 KV RF start with automatic shutdown following ignition. Active current limit during lamp warmup.
<u>Output Options:</u>	<u>350 Watt mercury lamp</u> Idle: 275 - 350 Watts (depending on application) Maximum power: 500 Watts Minimum power: 200 Watts Maximum Voltage: 75 Volts <u>200 Watt mercury lamp</u> Idle: 195 Watts Maximum power: 260 Watts Minimum power: 135 Watts Maximum Voltage: 70 Volts
<u>Mains Input Option:</u>	100 ±10 VAC 50/60 Hz Japan 120 ±12 VAC 50/60 Hz U.S. 208 ±20 VAC 50/60 Hz U.S., Europe 240 ±25 VAC 50/60 Hz U.S., Europe Dual circuit breakers on front panel; trip current depends on selected option.
<u>Optical Sensor:</u>	Dual channel using silicon photodiodes with selected glass absorption filters. Normally 365nm channel 1 and 400 nm channel 2. Options for other wavelengths are available.
<u>Intensity Set:</u>	Dual range: 0 - 10.00 mW/cm ² 0 - 100.0 mW/cm ² Front panel selectable. Front panel Set and Calibrate pots for both channels.
<u>Lamp Hour Meter:</u>	5-digit non-resettable on front panel. Lamp operating hours only.
<u>EMI & RFI:</u>	Meets FCC requirement for EMI and RFI emissions from switching regulator power supplies.

Dimensions: 28.6 cm wide X 18.4 cm high X 40.7 cm long.
11.25 in. wide X 7.25 in. high X 16 in. long.

Weight: 22.7 Kg; 50 pounds.

Model 505C
Optical Energy Controller

Output: 500 watts maximum continuous.
130 Volts DC open circuit.
10 amperes active current limit.

Efficiency: greater than 90% power in to lamp, power out +17 Watts.

Regulation: $\pm 5\%$ over selected mains input range.

Ripple & Noise: less than 50 mVpp - mains fundamental and harmonic, 50 KHz.

Response Time: less than 1mS electrical (actual system dependent on lamp thermal response).

Lamp Ignition: 30 KV RF start with automatic shutdown following ignition.
Active current limit during lamp warmup.

Output Options: 250 Watt mercury lamp
Idle: 220 Watts
Maximum power: 320 Watts
Minimum power: 200 Watts
Maximum Voltage: 75 Volts

Mains Input Option: 100 ± 10 VAC 50/60 Hz Japan
120 ± 12 VAC 50/60 Hz U.S.
208 ± 20 VAC 50/60 Hz U.S., Europe
240 ± 25 VAC 50/60 Hz U.S., Europe

Dual circuit breakers on front panel; trip current depends on selected option.

Optical Sensor: Dual channel using silicon photodiodes with selected glass absorption filters. Normally 365nm channel 1 and 400 nm channel 2. Options for other wavelengths are available.

Intensity Set: Dual range: 0 - 10.00 mW/cm²
0 - 100.0 mW/cm²
Front panel selectable.
Front panel Set and Calibrate pots for both channels.

Lamp Hour Meter: 5-digit non-resettable on front panel. Lamp operating hours only.

EMI & RFI: Meets FCC requirement for EMI and RFI emissions from switching regulator power supplies.

Dimensions: 28.6 cm wide X 18.4 cm high X 40.7 cm long.
11.25 in. wide X 7.25 in. high X 16 in. long.

Weight: 22.7 Kg; 50 pounds.

Model 507
Optical Energy Controller

Output: 750 Watts maximum continuous
160 Volts DC open circuit.
12 amperes active current limit.

Efficiency: greater than 90% power in to lamp, power out +17 Watts

Regulation: $\pm 1.5\%$ over selected mains input range.

Ripple & Noise: less than 50 mVpp = mains fundamental and harmonic, 50 KHz.

Response Time: less than 1ms electrical (actual system dependent on lamp thermal response).

Lamp Ignition: 30 KV RF start with automatic shutdown following ignition.
Active current limit during lamp warmup.

Output Options:

500 Watt mercury lamp
Idle: 425 - 500 Watts (depending on application)
Maximum power: 750 Watts
Minimum power: 350 Watts
Maximum Voltage: 85 Volts

350 Watt mercury lamp
Idle: 275 - 350 Watts (depending on application)
Maximum power: 500 Watts
Minimum power: 200 Watts
Maximum Voltage: 75 Volts

Mains Input Option: 100 ± 10 VAC 50/60 Hz Japan
120 ± 12 VAC 50/60 Hz U.S.
208 ± 20 VAC 50/60 Hz U.S., Europe
240 ± 25 VAC 50/60 Hz U.S., Europe

Dual circuit breakers on front panel; trip current depends on selected option.

Optical Sensor: Dual channel using silicon photodiodes with selected glass absorption filters. Normally 365nm channel 1 and 400 nm channel 2. Option for other wavelengths are available.

Intensity Set: Dual range: 0 - 10.00 mW/cm^2
0 - 100.0 mW/cm^2
Front panel selectable.
Front panel Set and Calibrate pots for both channels.

Lamp Hour Meter: 5-digit non-resettable on front panel. Lamp operating hours only.

EMI & RFI: Meets FCC requirement for EMI and RFI emissions from switching regulator power supplies.

Dimensions: 28.6 cm wide X 18.4 cm high X 40.7 cm long.
11.25 in. wide X 7.25 in. high X 16 in. long.

Weight: 29.5 Kg; 65 pounds.

Model 515
Optical Energy Controller

Output: 1.5 Kilo Watts maximum continuous.
180 Volts DC open circuit.
24 amperes active current limit.

Efficiency: greater than 90% power in to lamp, power out +35 Watts.

Regulation: $\pm 0.5\%$ over selected mains input range.

Ripple & Noise: less than 50 mVpp - mains fundamental and harmonic, 50 KHz.

Response Time: less than 1ms electrical (actual system dependent on lamp thermal response).

Lamp Ignition: 30 KV RF start with automatic shutdown following ignition.
Active current limit during lamp warmup.

Output Options: 1 Kilo Watt mercury lamp
Idle: 900 - 1000 Watts (depending on application)
Maximum power: 1500 Watts
Minimum power: 700 Watts
Maximum Voltage: 95 Volts

Mains Input Option: 200 ± 20 VAC 50/60 Hz Japan
208 ± 20 VAC 50/60 Hz U.S., Europe
240 ± 25 VAC 50/60 Hz U.S., Europe

Dual circuit breakers on front panel; trip current depends on selected option.

Optical Sensor: Dual channel using silicon photodiodes with selected glass absorption filters. Normally 365nm channel 1 and 400 nm channel 2. Options for other wavelengths are available.

Intensity Set: Dual range: 0 - 10.00 mW/cm²
0 - 100.0 mW/cm²
Front panel selectable.
Front panel Set and Calibrate pots for both channels.

Lamp Hour Meter: 5-digit non-resettable on front panel. Lamp operating hours only.

EMI & RFI: Meets FCC requirement for EMI and RFI emissions from switching regulator power supplies.

Dimensions: 38.9 cm wide X 23.2 cm high X 40.7 cm long.
15.33 in. wide X 9.125 in. high X 16 in. long.

Weight: 43.1 Kg; 95 pounds

Model 505X Deep UV
Optical Energy Controller

Output: 500 Watts maximum continuous.
60 Volts DC open circuit.
18 amperes active current limit.

Efficiency: greater than 85% power in to lamp, power out +17 Watts.

Regulation: +1.0% over selected mains input range.

Ripple & Noise: less than 50 mVpp - mains fundamental and harmonic,
50 KHz.

Response Time: less than 1mS electrical (actual system dependent on
lamp thermal response).

Lamp Ignition: 30 KV RF start with automatic shutdown following ig-
nition. Active current limit during lamp warmup.

Output Options:

350 Watt Hg-Xe Lamp	200 Watt Hg-Xe Lamp
Idle: 275 - 350 Watts	195 Watts
Maximum power: 500 Watts	260 Watts
Minimum power: 200 Watts	135 Watts
Maximum Voltage: 40 Volts	30 Volts

300 Watt Xe Lamp
Idle: 275 Watts
Maximum power: 500 Watts
Minimum power: 200 Watts
Maximum Voltage: 30 Volts

Mains Input Options:

100	+10 VAC 50/60 Hz Japan
120	+12 VAC 50.60 Hz U.S.
208	+20 VAC 50/60 Hz U.S., Europe
240	+25 VAC 50/60 Hz U.S., Europe

Intensity Set: Dual range: 0 - 10.00 mW/cm²
0 - 100.0 mW/cm²
Front panel selectable.
Front panel Set and Calibrate pots for both channels.

Lamp Hour Meter: 5-digit non-resettable on front panel. Lamp operating
hours only.

EMI & RFI: Meets FCC requirement for EMI and RFI emissions from
switching regulator power supplies.

Dimensions: 28.6 cm wide X 18.4 cm high X 40.7 cm long.
11.25 in. wide X 7.25 in. high X 16 in. long.

Weight: 22.7 Kg; 50 pounds.

Model 507X Deep UV
Optical Energy Controller

Output: 750 Watts maximum continuous.
75 Volts DC open circuit.
35 amperes active current limit.

Efficiency: greater than 85% power in to lamp, power out +17 Watts.

Regulation: +1.0% over selected mains input range.

Ripple & Noise: less than 50 mVpp = mains fundamental and harmonic,
50 KHz.

Response Time: less than 1mS electrical (actual system dependant on
lamp thermal response).

Lamp Ignition: 30 KV RF start with automatic shutdown following ig-
nition. Active current limit during lamp warmup.

Output Options: 500 Watt Hg-Xe lamp
Idle: 425 - 500 Watts
Maximum power: 750 Watts
Minimum power: 350 Watts
Maximum Voltage: 45 Volts

500 Watt Xe lamp
Idle: 425 - 500 Watts
Maximum power: 750 Watts
Minimum power: 350 Watts
Maximum Voltage: 35 Volts

Mains Input Options: 100 +10 VAC 50/60 Hz Japan
120 +12 VAC 50/60 Hz U.S.
208 +20 VAC 50/60 Hz U.S., Europe
240 +25 VAC 50/60 Hz U.S., Europe

Intensity Set: Dual range: 0 - 10.00 mW/cm²
0 - 100.0 mW/cm²
Front panel selectable.
Front panel Set and Calibrate pots for both channels.

Lamp Hour Meter: 5-digit non-resettable on front panel. Lamp operating
hours only.

EMI & RFI: Meets FCC requirements for EMI and RFI emissions from
switching regulator power supplies.

Dimensions: 28.6 cm wide X 18.4 cm high X 40.7 cm long.
11.25 in. wide X 7.25 in. high X 16 in. long.

Weight: 29.5 Kg; 65 pounds.

Model 515X Deep UV
Optical Energy Controller

Output: 1.5 Kilo Watts maximum continuous.
85 Volts DC open circuit.
50 amperes active current limit.

Efficiency: greater than 85% power in to lamp, power out +35 Watts.

Regulation: +1.0% over selected mains input range.

Ripple & Noise: less than 50 mVpp - mains fundamental and harmonic,
50 KHz.

Response Time: less than 1mS electrical (actual system dependent on
lamp thermal response).

Lamp Ignition: 30 KV RF start with automatic shutdown following ig-
nition. Active current limit during lamp warmup.

Output Options:

<u>1 Kilo Watt Hg-Xe Lamp</u>	<u>1 Kilo Watt Xe Lamp</u>
Idle: 900 - 1000 Watts	900 - 1000 Watts
Maximum power: 1400 Watts	1400 Watts
Minimum power: 700 Watts	700 Watts
Maximum voltage: 50 Volts	40 Volts

Mains Input
Option:

200	+20 VAC 50/60 Hz Japan
208	+20 VAC 50/60 Hz U.S., Europe
240	+25 VAC 50/60 Hz U.S., Europe

Intensity Set: Dual range: 0 - 10.00 mW/cm²
0 - 100.0 mW/cm²
Front panel selectable.
Front panel Set and Calibrate pots for both channels.

Lamp Hour Meter: 5-digit non-resettable on front panel. Lamp operating
hours only.

EMI & RFI: Meets FCC requirement for EMI and RFI emissions from
switching regulator power supplies.

Dimensions: 38.9 cm wide X 23.2 cm high X 40.7 cm long.
15.33 in. wide X 9.125 in. high X 16 in. long.

Weight: 43.1 Kg; 95 pounds.

2.6.2 Day-to-Day Variability

All internal reference voltages are derived from band-gap zener devices which are temperature compensated. Drift is therefore eliminated if an initial time period of ten minutes is allotted before performing a calibration. However, the internal A-D converter may exhibit an uncertainty of ± 1 LSB, which may show over a long period.

The major factors which will contribute to overall system drift appear to lie with the optical elements within the lamp housing. The optical sensor for the Controller is rarely placed directly in the optical beam, but rather its energy is derived by means of refraction through a cold mirror, the partial reflection from a beam splitter, or from an off-axis beam. Therefore any physical change to one or more of these elements due to temporal, vibratory or environmental means will result in an apparent system error. Secondly, location errors in measurement will also contribute. The uniformity of the beam in the majority of light systems range from $\pm 5\%$ up to $\pm 20\%$. A Calibration performed with the sensor of an external Powermeter at one point in the beam, and a check of calibration with the sensor at a second point, could differ by at least these percentages given.

Symptom

Possible Fault Condition

Lamp will not start.

- a. Connections between Controller and lamp are loose, shorted or have developed ohmic contacts. Check all connections especially those within the lamp housing.
- b. Start interlock activated. See Section 1.3.3.

Replace LED lights.

- c. Aged lamp causes overvoltage trip.
- d. Defective Controller Board Assembly.
- e. Defective Power Supply Assembly.
- f. Defective or disconnections in start circuitry or rear panel.

Lamp starts but Controller shuts down following after a short time.

- a. Lamp has been installed in reverse resulting in rapid gap erosion. Replace with new lamp and install correctly.
- b. Bad contacts in lamp housing. Clean and check all connections.
- c. Defective lamp. Replace.

Lamp intensity is low. Step changes in power, proceed slowly.

- a. Lamp is overcooled. See Section 2.1.2 and reduce air flow past lamp.
- b. Lamp has leaked to air. Replace.
- c. Gold band on lamp has deteriorated due to age. Replace.

Lamp intensity is low, but not overcooled.

- a. Improper alignment in lamp housing. Correct.
- b. Aged lamp with metal deposition on inside of bulb. Replace.
- c. Optical coatings on surfaces have deteriorated. Replace.
- d. Lamp installed in reverse. An AC/DC short-arc lamp will run reversed, but the gold band will block some of the light. Correct.

Intensity Display on Controller does not agree with that of external Powermeter.

- a. Measurement with external Powermeter was made at two different locations in the light beam.
- b. Measurement on external Powermeter was made with a probe where spectral response differs from that of the Controller.
- c. Change in optical properties or alignment of optical elements. Recalibrate system.
- d. Incorrect calibration in original settings.
- e. Tampering with control settings of Controller since original calibration.
- f. Insufficient light incident on Optical Probe.

Intensity will not maintain preset level in control

- a. The preset intensity is above or below the limits of the lamp power requirements. Check the "lock" LED which must be on if the system is in active control.
- b. Optical probe not installed.
- c. Controller is set to "Idle" rather than "Control".
- d. Idle remote interface activated. See Section 1.3.4.

- | | |
|---|--|
| | e. Defective Optical Probe Assembly. |
| | f. Defective Optical Control Board Assembly. |
| | g. No light on optical probe. |
| W/cm ² Display
reads negative
numbers or no
response. | a. Optical Probe not installed. |
| | b. Defective Probe Assembly. |
| | c. Defective Optical Control Board Assembly. |
| | d. No light on optical probe. |
| Will not maintain
correct Idle power | a. Lamp is overcooled. See Section 2.1.2 and
reduce air flow past lamp. |
| | b. Defective lamp. Replace. |
| | c. Bad contacts in lamp housing. Clean and
check all connections. |
| | d. Controller is set to Control. |
| | e. Defective Control Board Assembly. |
| Controller shuts
off after running
≈ 15 minutes.
Replace LED, does
not light. | a. Plugged air intake or exhaust port. Check
and clean. |
| | b. Defective fan. |
| | c. Defective Drive Board Assembly. |
| Circuit Breaker
on. Power On-Off
trips off. | a. Shorted output cables or lamp. |
| | b. Defective Drive Board Assembly. |

2.8 Service Information

2.8.1 Service Assistance

Should any difficulties arise with the use or operation of your Optical Energy Controller, and you are unable to resolve the problem using the Trouble Shooting Guide, assistance may be obtained from two sources. Factory personnel are available to answer questions and to provide guidance from 9 AM to 6 PM, Pacific time. Call us at telephone number (408) 496-6750. Mimir representatives are available in several locations throughout the United States and Europe. These personnel are quite knowledgeable and have been trained to provide first echelon service and

maintenance on Mimir equipment.

2.8.2 Field Repairs

Mimir representatives and their associated service departments are trained to replace board assemblies in the field. Optical Energy Controllers are designed on a modular concept. Board assemblies are entirely self-contained and can be interchanged between instruments without affecting performance. Replacement board assemblies are available within 48 hours notice and can be shipped by air overnight. Contact your local representative or call the factory for delivery.

2.8.3 Hazards

Lethal voltages are available within the chassis of the Controller. It is strongly suggested you not open the case and attempt repair, unless you are experienced in high power switching supplies and have a 500 Series Field Repair Manual in your possession. Mimir Instruments will assume no responsibility for damages suffered to personnel or equipment from any unauthorized attempts to repair an instrument.

2.8.4 Factory Repairs

Send a complete description of the problem to Mimir Instruments, Inc. You should include the following: Company name, Name of the individual to contact; Address; Telephone number; Model and serial number. Following receipt of this material we will issue an RMA and instruct you where to send the product.

Controllers must be shipped in an authorized container. If you ship in any other, the repaired unit will be returned in a new shipper, for which you will be billed. Repairs will be completed within 72 hours following receipt and returned by common carrier. Units determined not to be covered by warranty will be billed at the published price of labor, plus parts.

2.8.5 Replacement Parts

Part Number	Description	Model
500-026	Optical Control Board Assy.	All
500-023	Control Board Assembly.	All
500-027	Power Supply Board Assy.	505/507/505X
503-026	Power Supply Board Assy.	515/515X
500-024	Drive Board Assy.	505
500-036	Drive Board Assy.	505X
500-025	Drive Board Assy.	507
500-037	Drive Board Assy.	507X
503-027	Drive Board Assy.	515
503-032	Drive Board Assy.	515X
500-112	Operation Manual	All
500-112	Service Manual	All
500-005	Shipper	505/507
503-005	Shipper	515
500-006	Lamp Cable Assy.	505/507/515
		505X/507X
503-006	Lamp Cable Assy.	515X
200-000	Dual Optical Probe Assy. Std.	
200-004	Dual Optical Probe Assy. for Canon	
200-005	Dual Optical Probe Assy. for Kasper 2001-KP4	
200-006	Dual Optical Probe Assy. for K. Suss	
200-007	Beam Splitter for Kasper 1700	
200-008	Beam Splitter for Kasper 2001	

3. WARRANTY

Mimir is proud of its electro-optical equipment and strives to maintain a reputation for having thoroughly tested reliable products. Mimir extends to you, as the owner, the warranty set forth below.

3.1 Warranty Period

Mimir products are warranted for a period of one year from the date of original purchase.

3.2 Scope of Warranty

Except as specified below, this warranty covers all defects in material and workmanship in Mimir products.

- 1) Batteries.
- 2) Voltage conversions.
- 3) Periodic checkups which do not disclose any defects covered by the warranty.
- 4) Units on which the serial number has been effaced, modified, or removed.
- 5) Damage or deterioration:
 - a) Occurring to any external cabinet or case.
 - b) Resulting from accident, misuse, abuse, neglect, unauthorized product modification or failure to follow instructions contained within the owner's Operations Manual.
 - c) Resulting from repair or attempted repair by anyone not authorized by Mimir.
 - d) Resulting from installation of parts or accessories that do not conform to the quality or specifications of the original parts or accessories.
 - e) Occurring during shipment. (Claims must be presented to the carrier.)

3.3 Who is Protected

This warranty will be enforceable by the original purchaser and by any subsequent owner during the warranty period, so long as proof of warranty coverage is submitted whenever warranty service is required.

3.4 What We Will Pay For

Mimir will pay for all labor and material expenses for covered items. Payment of shipping charges is discussed in the next section.

3.5 How to Obtain Warranty Performance

If transportation of your Mimir product presents unusual difficulties, please advise us and we may make special arrangements with you. Otherwise, the following procedures apply:

- 1) If your Mimir product ever needs service, you should do one of the following:
 - a) Contact your local Mimir Sales Representative or Authorized Service Center.
 - b) Send a complete description of the problems to Mimir Instruments, Inc. You should include the following: Company name; Name of individual to contact; Address; Telephone number; Model and serial number of the product; Copy of the original bill of sale or purchase order; A description of the electrical connections to associated equipment and a list of such equipment. Following receipt of this material, we will instruct you where to send the product or we may direct you to an authorized Service Center.
- 2) Although you must pay any shipping charges, if it is necessary to ship the product for warranty service,

we will pay the return shipping charges if the repairs are covered by the warranty.

3.6 Limitation of Implied Warranties

All implied warranties, including warranties of merchantability and fitness for a particular purpose are limited in duration to the length of this warranty, unless otherwise provided by state law.

3.7 Exclusions of Certain Damages

Mimir's liability is limited to the repair or replacement, at our option, of any defective product and shall in no event include incidental or consequential commercial damages of any kind.

4. FIELD REPAIR MANUAL

A field manual is available for those who wish to perform their own maintenance or repairs on out of warranty instruments. This manual includes full schematics and parts locators for the full series of Optical Energy Controllers. It is suggested that anyone attempting their own repairs, attend a factory class on the design and operation of the instrument and have access to standard electrical test equipment prior to commencement. Order Mimir part No. 550-112 to obtain this information.

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